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September 20th, 2013
File No: 1265-Final Report

Alberni-Clayoquot Regional District
3008 Fifth Avenue
Port Alberni, B.C. V9Y 2E3

Attention: **Mr. Andy Daniel, AScT**
Manager of Environmental Services

Re: Bamfield – Water System Study. Final Report

We are pleased to submit five bound, one unbound and one PDF copy of our Final Report for the Bamfield – Water System Study.

The report outlines the results of the computer network analysis of the water system and the improvements required to meet the pressure and flow requirements as the population increases over the next 40 years.

This study provides recommendations to meet the following objectives for the water system:

- Carry out a review of existing and future population and water demands for the Bamfield Water System.
- Prepare a computer model of the system and analyze the ability of the system to supply peak day and fire flow demands under current and future development conditions.
- Review of the existing chlorine residuals and determine improvements to improve chlorine residuals in the system.
- Determine the improvements required to meet present and future conditions.
- Prepare a capital project listing, including project description, project timing and project cost, for the required system improvements.
- Determine possible options for future requirement of VIHA's 4-3-2-1 water treatment.

We would be pleased to present the report to staff, at the Regional District's convenience, and we look forward to opportunities to assist in the implementation of the recommendations.

Yours truly,

KOERS & ASSOCIATES ENGINEERING LTD.

Mitchell Brook, P.Eng
Project Engineer

Chris Downey, P.Eng.
Project Manager

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APPENDICES

1. INTRODUCTION

1.1 Authorization and Scope

Koers & Associates Engineering Ltd. was authorized to proceed with this study in November 2012. The scope of the work is defined in the proposal prepared by Koers & Associates for the Alberni-Clayoquot Regional District (ACRD) dated September 21, 2012, and includes the following work:

The deliverables required on completion of the study are the following:

- Five bound copies of the final report, which discusses the population projections, peak water demands, fire demands, analysis criteria for the water model, results of the analysis of options, capital project requirements, conclusions and recommendations.
- Plan of the study area showing existing features relevant to water distribution, proposed improvements, land use, and cadastral information.
- Other plans to describe the improvements proposed.

1.2 Background

1.2.1 Bamfield Water System Overview

The Bamfield water system is located on the west coast of Vancouver Island approximately 55 km southwest of Port Alberni. The water system was originally constructed between 1979 and 1980. The water system is supplied from Sugsaw Lake through an intake and submarine pipeline across Grappler Inlet to the pump station at Port Desire. The pump station supplies the distribution system and fills the existing reservoirs. The pump station is controlled by the top water level of the reservoirs and operates when the water level drops below the current set points. The distribution system is comprised of approximately 11,000 m of watermain piping varying in diameter from 25 mm to 150 mm. The west side of Bamfield inlet is supplied through two submarine pipelines, one 150 mm dia. main and one 50 mm dia. main.

The water system supplies approximately 207 residential and commercial service connections and an estimated permanent population of 155 people. The community of Bamfield has experienced a significant decline in permanent population in recent years from a population of 251 in 2006 to 155 in 2011, based on Census information. However, the village experiences a large increase in population during the summer, for a total summer population estimated at 2,000 in 2011. The ACRD estimates that by 2053 the effective summer population in Bamfield to be serviced by the water system will have increased to 3,246 people, which is the design population used for water system improvements considered in this report. The increase in population during the summer months is mainly due to the use of many of the properties as seasonal residences and recreational rentals. In this report, the maximum day and peak hour demand conditions will reflect the seasonal increase in population. A detailed description of the population and demand projections are listed in Section 2.0 and 3.0, respectively.

1.2.2 Previous Reports

McGill & Associates Engineering Ltd. – 2004 Bamfield Water Study

In 2004 McGill & Associates Engineering Ltd. presented a detailed report on the Bamfield water system for the ACRD. The purpose of this report was to review the existing water system, identify deficiencies in the system, project future demands, and identify improvement options to service the Bamfield water system. The report also reviewed the potential for a new supply main from Sugsaw Lake as well as the potential to supply the local First Nations Reserves.

Based on the information available at the time of the report, McGill & Associates provided the following recommendations:

1) Conduct a review of the existing intake structure, work on source protection, start a community committee.
2) Hold discussions with the Huu-ay-aht First Nation to review the potential for backup water supply alternatives between the two water systems.
3) Hold discussions with the Marine Station to determine if there is interest in purchasing the existing supply main from Sugsaw Lake, should a new supply main be constructed.
4) Construct a new supply main from Sugsaw Lake based on Option No. 4 identified in the report.
5) Complete the improvements to the distribution system identified in the report.
6) Construct a new storage reservoir on the west side of the Bamfield inlet to provide emergency backup to the system in the event of a pipe failure to the supply main to west Bamfield.

ACRD – Bamfield Water System Description 2006-2009

The ACRD provided a brief description of the Bamfield water system as part of the request for proposals for the water study. This report provides a brief description of the water system, comments on the water quality testing procedures for the distribution systems, and comments on some of the improvement options listed in the McGill & Associates Engineering report. Based on information listed in the report the water licence for Sugsaw Lake allows an annual withdrawal of 91,250,000 gallons and the 2009 annual water usage was 11,726,717 gallons (53,311 m^3).

The report also notes that the system experiences significant leakage.

ACRD – 2011 Annual Water System Report

The ACRD 2011 annual water system report provides an overview of the water systems which the ACRD owns and operates. As identified in the report, at the time the Bamfield water system had the highest annual consumption of the seven water systems operated and maintained by the ACRD.

The report provides a brief history and description of the Bamfield water system. Key items of the water system identified in the report are:

1) Water source is from Sugsaw Lake.

2) Water treatment is through a fine screen intake with chlorine disinfection at the pump station.
3) There are two storage reservoirs with a total capacity of 144,000 us gallons.
4) There are 207 service connections.
5) There is approximately 4,550 m of 150 mm dia. mains, 1,300 m of 100 mm dia. mains, 5,175 m of 50 mm dia. mains, and 325 m of 25 mm mains.
6) The watermain materials are PVC and polyethylene.
7) The average daily demand is 142 m^3.

The report also notes that the water system has experienced leaks in the distribution system. There is a backup generator at the pump station which starts automatically during power failure, to maintain service, however the control panel needs to be reset manually.

Ministry of Environment – 2012 Water Quality Assessment of Sugsaw Lake

In April of 2012, the Ministry of Environment published a report on the Water Quality Assessment and Objectives for Sugsaw Lake, which summarized the findings of the water quality data that was collected between 2007 and 2010. The report concludes that the overall water quality was good with occasional "slightly elevated turbidity levels and naturally high colour".

The report is based on water sampling from a sample station established at the deepest part of the lake in the northeast end and also at the current intake location. The results indicated elevated levels of colour with an average value of 30 True Colour Units (TCU), which is twice the Canadian Drinking Water Guidelines (CDWG) allowable limit of 15 TCU. The report also comments that high colour values are usually associated with elevated levels of total organic carbon (TOC), which produce harmful disinfection by-products from chlorination (trihalomethanes or THM's) and concludes that additional treatment may be required to remove the organic carbon prior to chlorination.

1.2.3 Water Quality Reports

Water quality reports for Sugsaw Lake were provided by the ACRD for 2011 and 2012. Copies of these reports are included in Appendix A. The samples were taken at the end of November near the existing intake location and show colour levels of approximately 50 TCU. The 2011 sample did not include a TOC analysis however; the 2012 sample shows a TOC level of 5.7 mg/l. Both parameters are significantly above the CDWG, which are 15 TCU for colour and 0.5 mg/l for TOC. With the exception of the colour and TOC levels, the water quality of Sugsaw Lake consistently meets the CDWG.

Water quality samples were also taken at the Bamfield Reservoirs. No E. Coli or total coliforms were reported, however the colour was 14 TCU and the TOC was 5.0 mg/l. The analytical report also showed THM's with a concentration of 0.257 mg/l, which as indicated in the Ministry of Environment report is a result of the colour and TOC concentrations. The CDWG standard for THM is 0.1 mg/l.

Other water samples taken throughout the distribution system have also indicated elevated levels of THM's. Copies of the water quality reports for the distribution system are included in Appendix A.

1.3 Study Objectives

The following key objectives have been established for this study:

- Carry out a review of existing and future population and water demands for the Bamfield Water System.
- Prepare a computer model of the system and analyze the ability of the system to supply peak day and fire flow demands under current and future development conditions.
- Review of the existing chlorine residuals and determine improvements to improve chlorine residuals in the system.
- Determine the improvements required to meet present and future conditions.
- Prepare a capital project listing, including project description, project timing and project cost, for the required system improvements.
- Determine possible options for future requirement of VIHA's 4-3-2-1 water treatment.

1.4 Acknowledgements

Koers & Associates Engineering Ltd. acknowledges with thanks, the assistance provided by Regional District staff during the data collection, analysis and preparation of the report, specifically Russell Dyson, Andy Daniel, John Thomas, and Mike Irg for assistance in providing information on the service area population, anticipated population growth rates, system records, flow information, and in review and commenting on the draft report.

2. DESIGN POPULATIONS

2.1 Existing Population

Based on the 2011 Census data for the community of Bamfield the current permanent population is approximately 155 with 85 occupied dwellings (population density of 1.8 ppu) and a total of 169 dwellings. This is a significant decrease for the community since the 2006 Census, which listed a permanent population of approximately 251.

2.2 Population Projections

The ACRD has provided planning data for population projections. Even though a decline in population has occurred in the last five years, the ACRD is projecting a modest growth rate of 1% for the community to stay conservative for the purposes of this report. The OCP information provided by the ACRD indicates that there is potential for the community to increase by an additional 80 properties under the current residential zoning. This would result in a total of 249 residential dwellings, including seasonal residential dwellings. The ACRD is suggesting an ultimate design occupancy of 2.2 people per dwelling, for a total future peak permanent and seasonal residential population of 548 people at OCP build-out.

In addition to the residential population, the Bamfield Marine Station has a permanent population at the facility. Through discussions with officials from the Marine Station, the population of the facility peaks in the summer months with a population of approximately 100. There is no anticipated growth in this population for the facility.

The ACRD has further indicated that the current total peak summer population in Bamfield can reach as much as 2,000 people, including permanent and seasonal residents, the Marine Station staff and tourists visiting the area. In the absence of better estimates, for the purposes of this report, we have assumed that the current tourist population would be approximately 1,745 and that the tourist population would increase at the same growth rate as the community for a year 2053 (40-year) projected maximum design population of 3,246 people, including 235 permanent residential, 100 Marine Station and 2,911 peak seasonal population.

3. WATER DISTRIBUTION SYSTEM

3.1 System Description

The Bamfield water system is supplied from Sugsaw Lake through a shallow intake and a 150 mm dia. submarine supply main through Grappler Inlet to the existing pump station at Port Desire. The water is chlorinated prior to the pump station and flows through two 400 mm dia. mains to achieve the required chlorine contact time before the water is supplied to the distribution system.

The existing pump station has two Grundfos CR45 pumps that are rated for a flow of 15 lps @ 75.4 m TDH. However, the pumps have been throttled to a flow rate of 10 lps in order to minimize the headloss in the supply main from Sugsaw Lake and maintain the required minimum pressure at the inlet of the pump station. The pump station is controlled by the level in the reservoirs with the first pump called on when the water level in the reservoirs drops by 1200 mm. The system is not set up for the lag pump to operate.

The existing reservoirs supply the distribution system and are located at the east end of Binnacle Road. The combined capacity of the reservoirs is 545 m^3 (144,000 US gallons). Based on information available it is estimated that the top water level of the reservoir is approximately 79.3 m geodetic. The original tank was constructed in 1980 with the second reservoir added in 1997. It is recommended that the existing reservoirs be cleaned and painted, as part of a regular maintenance schedule, in order to maximize the service life of the reservoir.

The distribution system is comprised of PVC and polyethylene watermains ranging in size from 25 mm to 150 mm. Based on discussions with the ACRD there are areas of the distribution system where the existing watermain piping is exposed and other areas where the watermain is constructed out of thin walled electrical conduit.

The supply and distribution system is detailed on Figure 1 – Existing Water System

3.2 Design Criteria

The adequacy of the distribution system for various demand conditions is judged by the residual pressure available throughout the system, and by resulting velocity in the mains. Normally accepted criteria for system adequacy are the following:

Peak Hour Demand Conditions

1)	Minimum residual pressure at property line	275 kPa (40 psi)
2)	Maximum main velocity	1.5 m/s

Fire Flow Conditions

1)	Minimum residual pressure at hydrant	138 kPa (20 psi)
2)	Minimum residual pressure at property line	34 kPa (5 psi)

Chlorine Residual

1)	Minimum chlorine residual in the system	0.2 mg/l (2 ppm)

3.2.1 Water Demand Criteria

Water demand information for 2006 to 2012 was provided by the ACRD. Based on the information provided, average annual consumption for the water system over the past seven years is 51,995 m^3, for an average day demand (ADD) of 1.65 lps. Only monthly water use records are available. The average maximum monthly consumption was 8,680 m^3, with an estimated maximum day demand (MDD) of 4.86 lps, using a factor of 1.5 for maximum month to maximum day. The recorded per capita demands are summarized below in Table 1. Please note that the per capita demand for the ADD is based on the permanent population and the per capita demand for the MDD is based on the maximum seasonal population.

Table 1: Per Capita Demands

Year	Permanent Population	Marine Station	Peak Seasonal	Total Peak Population	Annual Consumption (m^3)	Maximum Monthly Consumption (m^3)	ADD (lps)	MDD (lps)
2006	251	100	1,649	2,000	54,818	8,916	1.74	4.99
2007	230	100	1,670	2,000	47,679	8,049	1.51	4.51
2008	210	100	1,690	2,000	47,124	7,213	1.49	4.04
2009	190	100	1,710	2,000	53,311	9,881	1.69	5.53
2010	170	100	1,730	2,000	56,939	9,881	1.81	5.53
2011	155	100	1,745	2,000	51,875	8,500	1.64	4.76
2012	155	100	1,745	2,000	52,220	8,321	1.66	4.66
				Average	**51,995**	**8,680**	**1.65**	**4.86**
						Per Capita Demands (lpcd)	**559**	**210**

For the purposes of this report, to provide a conservative estimate of the system demands, the following design per capita demands are proposed:

Average Day Demand (ADD) = 560 lpcd
Maximum Day Demand (MDD) = 210 lpcd
Peak Hour Demand (PHD)* = 336 lpcd

*For this report, it has been assumed that the PHD is 1.6 times the MDD as per the BC Design Guidelines for Rural Residential Communities.

System water demands were estimated using the population projections and per capita demands and are summarized below in Table 2.

Table 2. Water Demands

					Demand (lps)		
Year	Permanent Population	Marine Station	Peak Seasonal Population	Maximum Population	ADD (560 lpcd)	MDD (210 lpcd)	PHD (336 lpcd)
2013	158	100	1,758	2,016	1.67	4.90	7.84
2023	175	100	2,071	2,345	1.78	5.70	9.12
2033	193	100	2,402	2,695	1.90	6.55	10.48
2043	213	100	2,687	3,000	2.03	7.29	11.67
2053	235	100	2,911	3,246	2.17	7.89	12.62

The population projections, were provided by the ACRD planning department and the water demands have been reviewed and accepted by the ACRD as per email

≤ 50 DIA. WATERMAINS

100 DIA. WATERMAINS

150 DIA. WATERMAINS

400 DIA. WATERMAINS

WATER SYSTEM BOUNDARY

R T.W.L. 132.00m — RESERVOIR

PS — PUMP STATION

Eagle Bay

Bamfield Inlet

Port Desire

Inlet

Sugsaw Creek

IR. 4 (SACHSA)

BAMFIELD

T.W.L. 79.3m

Calamity Lake

Bamfield Inlet

Bamfield Inlet

WESTMINSTER AVE

BURLINGTON AVE

WINSTON AVE

NUTHATCH ROAD

TOWER RD

FRIGATE ROAD

HULL ROAD

SEABIRD RD

PACHENA RD

MAHK ROCK RD

ISLAND RD

BURLO

SOUTH BAMFIELD RD

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PROJECT: BAMFIELD WATER SYSTEM WATER STUDY

TITLE: EXISTING WATER SYSTEM

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DWG No.	1265-Fig. 1

correspondence from Andy Daniel on March 19, 2013 through consultation with Eric Geall.

It is recommended that the ACRD continue to record the water consumption for the community and if possible implement methods to record the maximum daily flows in the summer months to confirm the design demand projections of the report.

3.2.2 Available Water License

The conditional water license for withdrawal from Sugsaw Lake (license No. C055723) was issued on July 15th, 1981 to the ACRD for a maximum daily quantity of 250,000 gallons/day (13.2 lps). A copy of this water license is included in Appendix B. Based on the projected demands the water license is adequate for the community well beyond 2053.

3.2.3 Fire Demand Criteria

Design fire demands in the study area vary, due to the different zoning classifications. Fire Underwriters Society (FUS) design standards specify the following minimum fire flows to be met, in conjunction with maximum 24-hour demand:

Zoning	Required Fire Flow
Single Family Residential	33 lps (435 igpm)
Commercial/Institutional	Varies with building data

Commercial and institutional fire flow requirements are based on the building size and materials of construction. Required fire flows for specific installations should be calculated in accordance with the FUS design guidelines.

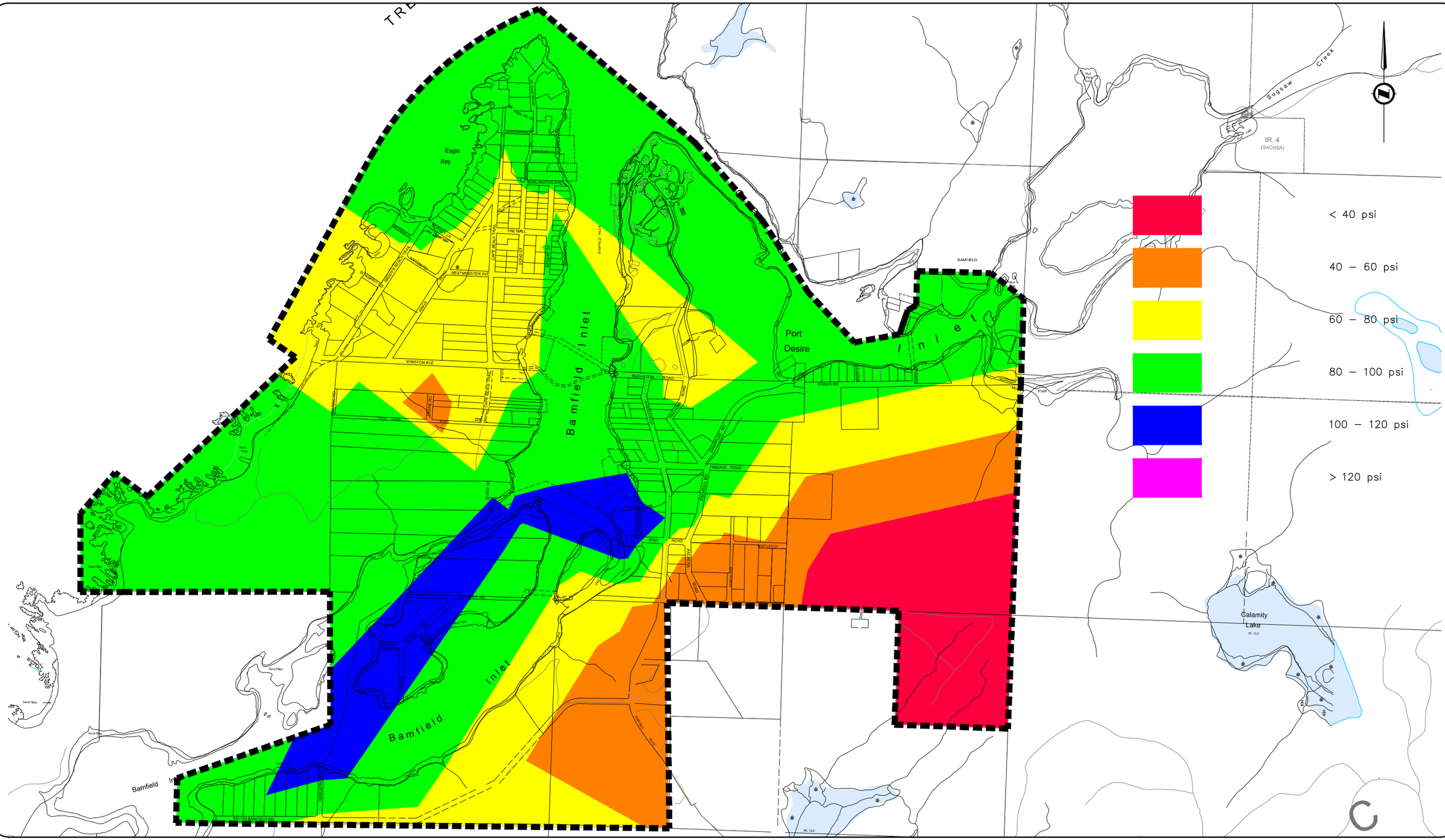
3.3 Water Model

A new water model for the Bamfield Water System was created using the computer software WaterCAD V8*i*, water system map information provided by the ACRD, and available record drawings. It should be noted that the ACRD was unable to provide contour maps or other elevation data. Elevations for the model have been assumed, based on limited available information. Once the model was created, the existing water demands were entered for MDD and PHD demand conditions. The reservoir information was added to the model, including the basic reservoir dimensions, storage volumes, top water levels and interpreted reservoir controls for the pump station operation.

3.4 Modeling Results – Distribution System

3.4.1 Peak Hour Pressures

The peak hour residual pressures for existing conditions are shown in Figure 2 – Existing Peak Hour Pressures. These results meet the standards for residual pressures at the property line with the exception of the area on Binnacle Road east of Seabird Way, as the ground elevation exceeds 50 m. If the area east of the reservoir were to be developed in the future, a pump station would be required in order to service any lots above an elevation of 50 m. The minimum peak hour pressure in the distribution system is approximately 42 psi at the intersection of Bamfield Road and Imperial Eagle Drive.



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DWG No.	1265–Fig. 2

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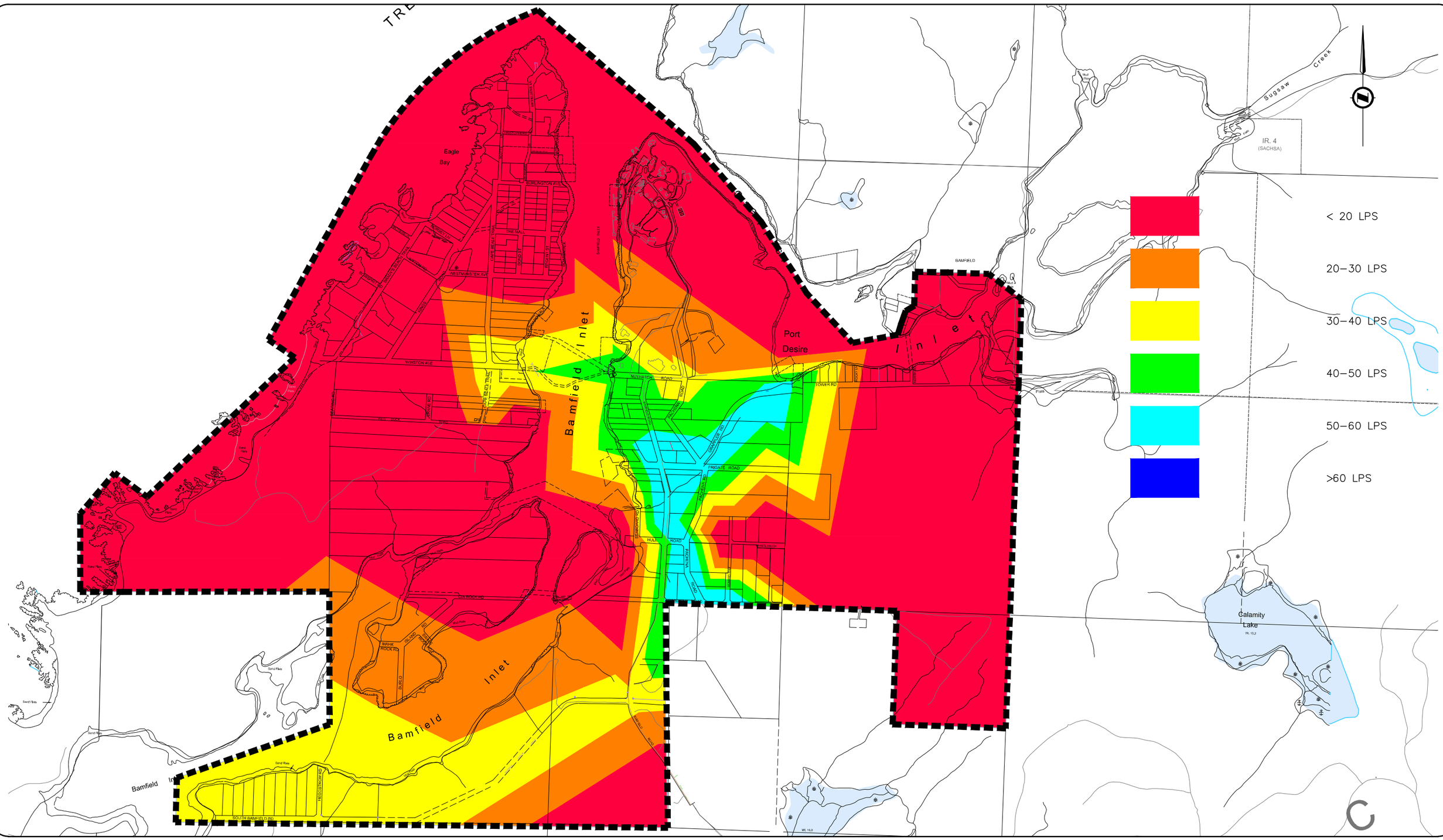

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TITLE	EXISTING AVAILABLE FIRE FLOWS
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PROJECT No.	1265
SCALE	1:12,500
DWG No.	1265–Fig. 3

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3.4.2 Available Fire Flows

The available fire flows under existing maximum day demand conditions are shown on Figure 3 – Existing Available Fire Flow. It should be noted that the great majority of the system to the west side of Bamfield Inlet does not meet the minimum required fire flow of 33 lps. In addition, the following areas in Bamfield East do not meet the required minimum fire flow requirements:

1) Seabird Way
2) Whistlebouy
3) Tower Road east of Rocky Lane
4) Bamfield Road south of Imperial Eagle Drive

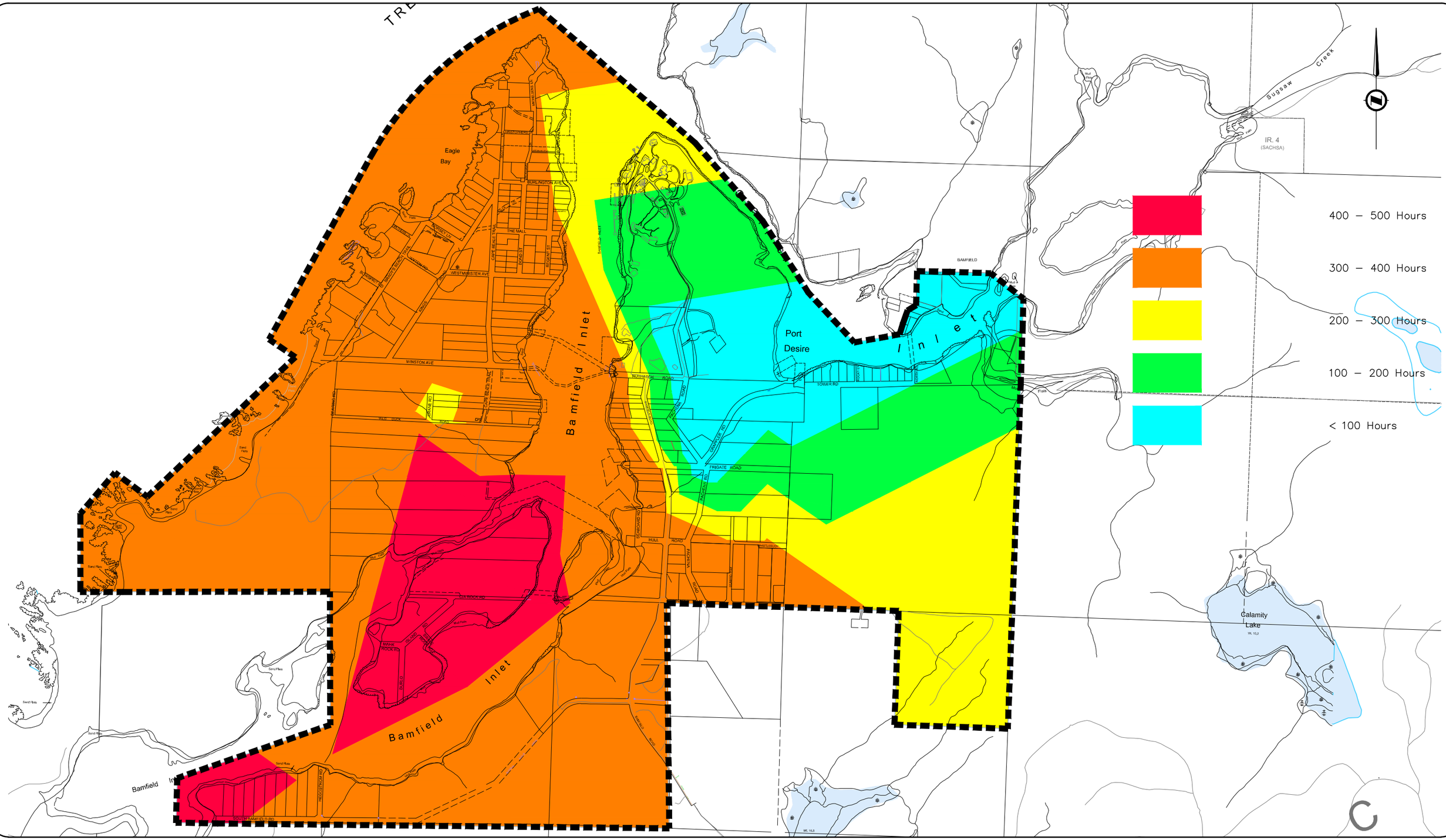
As noted in Section 3.2.3 the fire flow requirements for the institutional and commercial developments should be calculated based on the FUS design guideline and compared to the available fire flows in the specific areas.

Based on the piping in the existing distribution system, and the high costs of upgrading the existing system to meet the required fire flows, it is recommended that the system be treated as a domestic supply system only. This has been reviewed with the ACRD staff and will need to be agreed upon by the Bamfield Water Committee. Fire protection would be limited to the fire flows available with the current piping configuration.

3.4.3 Chlorine Residuals

In order to project the residual chlorine in the distribution system an analysis was performed to determine the age of the water in the distribution system, using the new computer model. The age of the water in the distribution is shown in Figure 4 – Water Age in Distribution System.

Since the chlorine decay rate of the system is a function of the water quality it is recommended that field measurements be conducted in order to determine the actual chlorine decay rate for the Bamfield water system. Once the decay rate is confirmed, the chlorine residual in the system can be projected using the water age analysis results.



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TITLE	EXISTING WATER AGE IN DISTRIBUTION SYSTEM
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DWG No.	1265–Fig. 4

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4. PROPOSED IMPROVEMENTS

4.1 Distribution System

The existing distribution system is adequate to supply the required system flows and no improvements are required based on the water model hydraulic capacity analysis.

The following improvements are proposed based on pipe condition and discussions with the ACRD:

1) Replace the existing DBII (electrical conduit) pipe that services the Coast Guard Station on the west side of Bamfield with a new 50 mm dia. PVC main (75 m)
2) Correct the suspended watermain on Towers Road (50 m).

As the majority of the piping was installed in the 1980s it is recommended that the ACRD prepare an infrastructure renewal program for replacement of the existing piping and components in the distribution system, as some may be nearing their useful life span. This renewal plan will allow the ACRD to plan for upgrades on a priority basis as the existing watermains reach their anticipated design life.

4.2 Supply System

The following improvements are recommended for the supply system:

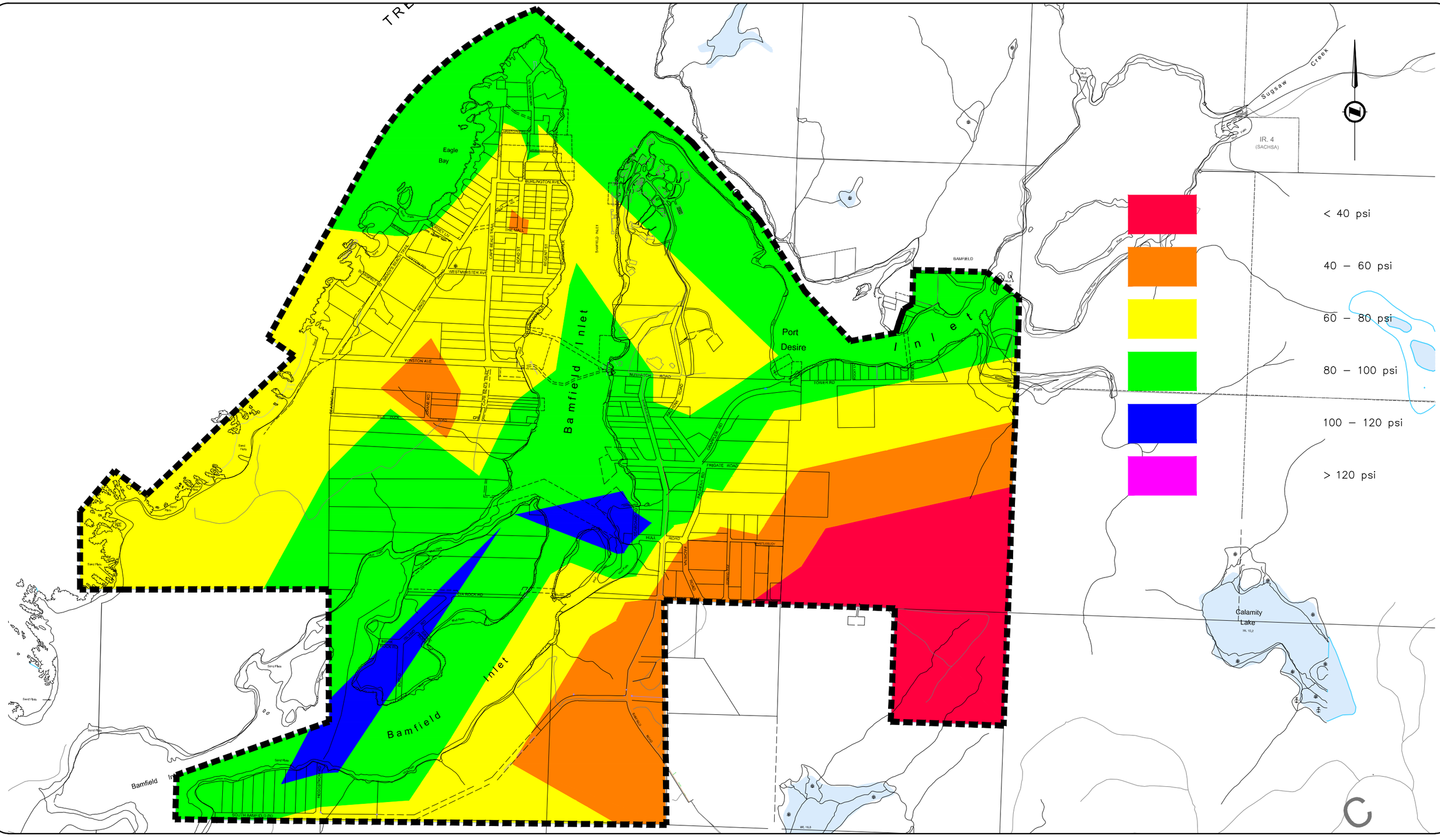
Pump Station and Reservoir Operation

As discussed in Section 3.1 the existing pump station has two pumps that are controlled by the top water level of the existing reservoirs. Based on a review of the existing pump information and settings, which has been included in Appendix C, the existing pumps are operating at approximately 70% efficiency. In order to optimize the reservoir function and reduce the age of the water in the system it is recommended that the pump station be upgraded to have two additional smaller duty pumps that will fill the reservoir at a lower flow rate and allow for better turnover in the reservoir. The two duty pumps should be designed for a range of 3.8 to 4.5 lps each, in order to match the 2053 maximum day demands. The lower flow rate will also reduce the headloss in the supply main and prevent negative pressures at the pump station inlet. The new duty pumps should be programmed such that the first pump is called on when the water level in the reservoirs drops 1,000 mm, and the second pump should be called on when the water level drops an additional 150 mm. The larger pumps should be kept to fill the reservoirs in case the smaller pumps would not be able to keep up with the demand under peak flow or fire flow conditions.

The peak hour residual pressures for the 2053 demand conditions with the proposed improvements are shown in Figure 5 – Future Peak Hour Pressures.

The age of the water in the distribution system for the 2053 demand conditions with the proposed improvements is shown in Figure 6 – Future Water Age in Distribution System.

The ACRD has recently installed a re-chlorination system and new flow meter at the reservoir site. This will allow the flow in and out of the reservoir to be documented as well as increase the residual chlorine levels to maintain the required residual in the system.



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TITLE	FUTURE PEAK HOUR PRESSURES
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SCALE	1:12,500
DWG No.	1265–Fig. 5

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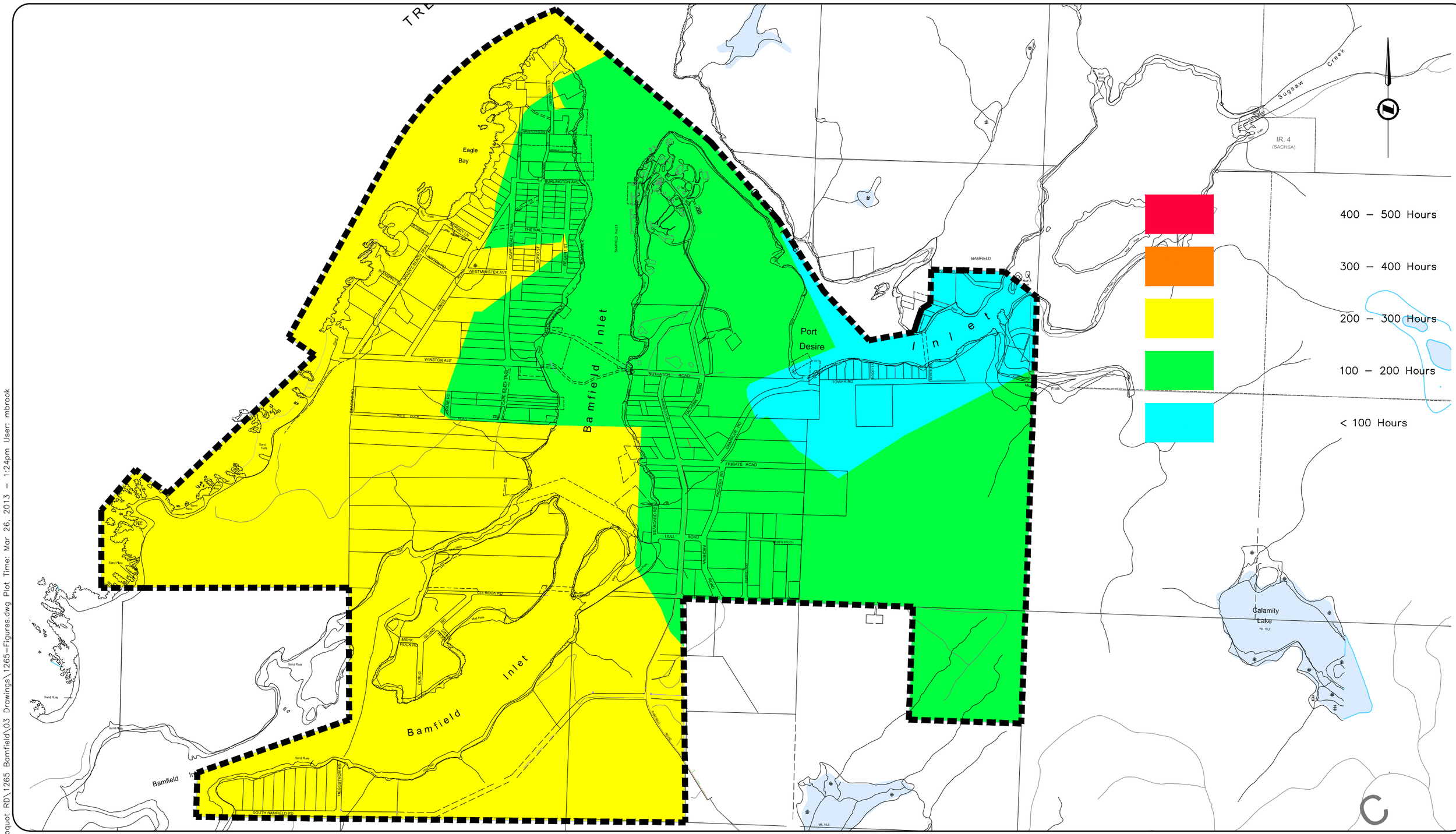

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SCALE	1:12,500
DWG No.	1265–Fig. 6

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Supply Main

It is understood, through discussions with the ACRD, that the existing submarine supply main is an HDPE main with flanged connections. Overall, the supply main appears to be in good condition and has sufficient capacity to supply the system with the proposed pump station improvements. For submarine installations it is not recommended to have flange connections underwater, as the flanges may deteriorate or start leaking at the gasket joint. The details or type of material of the flanges and gaskets are not known. It is recommended that the supply main be monitored for leakage and salt-water intrusion on a regular basis to confirm that the supply main integrity remains intact. If the supply main deteriorates or becomes compromised, a new submarine supply main should be installed to the pump station. The proposed supply main should be thermal fused HDPE DR21 pipe with an outside diameter of 200 mm to reduce headloss in the supply main piping.

Overland routing options are possible for the supply main, but in order to supply the distribution system a pump station will be required near the intake site. Listed below are design considerations that would need to be factored into the costs for an overland supply main:

1) Construction of a new pump station.
2) Construction of an adequate access road for pump station maintenance.
3) Power service for the pump station with either a diesel generator as a primary power supply or a new BC Hydro service with a backup generator.
4) Property acquisition for pump station and pipeline alignment.
5) Fisheries creek crossing costs for the overland pipeline alignment.
6) Environmental mitigation.

Intake

In addition, due to its age and poor condition, it is recommended that the intake structure be upgraded. The new intake should be installed at a greater depth in the lake to reduce influences of surface water activities and provide a lower water temperature. The access to the intake and connection to the supply main can remain at the current location and the ACRD should install a lockable gate at the walkway entrance in order to protect against vandalism. Details or cost estimates of the intake improvements required are not considered part of the scope of this assignment.

4.3 Reservoir Storage

4.3.1 Sizing Design Standard

The projected volume for required system storage was calculated using the following formula as listed in the BC Design Guidelines for Rural Residential Communities:

Volume (V) = A + B + C

Where: A = Fire Storage (33 lps for 1 hour)
B = Equalization (Peaking) Storage (25% of Maximum Day Demands)
C = Emergency Storage (25% of A + B)

The existing 2013 required storage for the water system is:

Storage Component	Design Standard	Storage (m^3)
Fire Storage (A)	33 lps for 1 hour	119
Peak Hour Balancing (B)	25% of Maximum Day Demand	101
Emergency Storage (C)	25% of A+B	55
Total Storage Requirement		**275**
Total Existing Storage		**545**

The future 2053 required storage for the water system is:

Storage Component	Design Standard	Storage (m^3)
Fire Storage (A)	33 lps for 1 hour	119
Peak Hour Balancing (B)	25% of Maximum Day Demand	170
Emergency Storage (C)	25% of A+B	72
Total Storage Requirement		**361**
Total Existing Storage		**545**

Based on the demand projections outlined in Section 3.2.1 the Bamfield water system will have adequate water storage well beyond 2053.

4.4 Water Treatment Options

In March 2008 VIHA adopted the 4-3-2-1 treatment rule for surface water, which specifies a minimum of 99.99% (4-log) removal of viruses, 99.9% (3-log) removal of *Cryptosporidium* and *Giardia*, a minimum of 2 separate treatment processes, usually filtration and disinfection, and maximum 1 NTU turbidity in the finished water supply.

Based on the water quality information provided by the ACRD, additional water treatment will be required to treat the high colour and TOC levels in Sugsaw Lake and the elevated THM levels in the distribution system.

There are several treatment options to remove colour and TOC in raw water, and it is recommended that pilot testing be completed in order to determine the optimal treatment process for the Bamfield water system. One treatment option, which has been used in Tofino, to treat elevated colour and TOC levels is dissolved air flotation (DAF). DAF is a multistage treatment process that is effective at treating raw water with high colour. The first stage of the process is flocculation, which involves the rapid mixing of a coagulant into the raw water to create colloidal particles (floc) that can be settled or filtered. Water is then sent through a flotation tank, in which tiny air bubbles are injected into the water causing the floc to float to the surface. Once the floc has collected at the surface, it is skimmed off to waste and the clean, treated water discharges the base of the tank. The DAF process is an effective alternative to sedimentation due to smaller plant a footprint and reduced flocculation times.

It should be noted that additional treatment processes for disinfection are still required after the water has been treated with the DAF system. Options for these processes include chlorine disinfection and UV treatment. Based on the Ministry of Environment's water quality sampling of Sugsaw Lake the average turbidity in the lake was 0.6 NTU in 27 samples. It appears that this source meets the turbidity requirements but it is recommended that further continuous turbidity monitoring of the lake be completed prior

to requesting filtration deferral approval from VIHA.

Cost estimates for a DAF water treatment plant, including additional water treatment processes to achieve VIHA's 4-3-2-1 treatment guidelines, piping and appurtenances and a new building are included in Section 5.0. It is recommended that the proposed treatment plant be located near the existing pump station in order to minimize the infrastructure upgrades to supply the treated water to the distribution system. The treatment plant can be constructed in a phased approach with the UV and chlorine disinfection installed under Phase I to address VIHA's 4-3-2-1 guidelines. The DAF process can be installed under Phase II to address the TOC issues with the source water from Sugsaw Lake.

4.5 Supply to First Nations Reserves

There are two First Nation reserves located near Bamfield. IR 4 (Sascha) is located at the north end of Grappler Inlet near Sugsaw Creek. Based on Census data there are no permanent residents at this location.

IR12 (Anacla) also known as Pachena Village is located south of Bamfield. Census data shows a population of 75 at this location. Based on discussions with the ACRD, Pachena Village has an established water system, which is supplied by a well and infiltration gallery in the Pachena River, but we are not sure of the adequacy or condition of this system. Assuming a population growth rate similar to Bamfield, the 2053 population of Pachena Village would be approximately 114. Applying water demands recommended by the Master Municipal Construction Documents (MMCD) the future design maximum day demands for the Pachena Village would be 1.58 lps. The additional flow to Pachena Village would be within the total withdrawal limits of the ACRD's water licence for Sugsaw Lake.

The ACRD should hold discussions with the First Nation to review the possibility of Pachena Village being supplied by the Village of Bamfield and possible cost sharing for a new water treatment plant. If there is interest in connecting to the Bamfield system a new supply main would be required along Bamfield Road from Imperial Eagle Drive to the Pachena Village water system, complete with a check valve and flow meter.

4.6 System Operation and Maintenance

It is recommended that the ACRD complete a review of the operation and maintenance procedures for the Bamfield water system in order to optimize the operation and service life of the system. As part of this review it is also recommended that a water sampling program be developed for both the distribution and supply system to provide a history of the water quality for the water system.

It is also recommended that a comparison between the supply flow meters and the individual service meters be completed in order to determine how much water is lost to leakage in the system. Additional meters could be installed on the submarine distribution mains in order to determine if there is leakage in the submarine mains.

As part of the long term maintenance for the water system an infrastructure renewal plan should be developed to allow for the community to plan for future watermain replacements as the existing infrastructure reaches the end of its design life.

5. COST ESTIMATES

5.1 Cost Estimates

Table 4 shows the construction cost estimates, to a Class D accuracy level (based on little or no site specific detailed engineering but provides an order of magnitude), for the various improvements and options outlined in the report. Costs shown are based on estimated early 2013 construction costs.

Table 4: Cost Estimates

Improvement	Description	Dia (mm)	Length (m)	Unit Cost	Extension
1.0	Upgrade Watermain to Coast Guard	50	75	$400	$30,000
2.0	Upgrade Watermain on Tower Road	50	50	$400	$20,000
3.0	Upgrade Existing Pump Station			$25,000	$25,000
4.0	Prepare Water System Operation and Maintenance Plan			$15,000	$15,000
5.0	New Water Treatment Plant Phase I - UV and Cl_2 Phase II - DAF			 $200,000 $1,000,000	 $200,000 $1,000,000
				Subtotal	$1,290,000
				Contingency (30%**)	$387,000
				Contingency (30%***)	$387,000
				Total	$2,064,000

[1] This project is based on colour and TOC removal only. If a filtration deferral cannot be obtained from VIHA this cost estimate will need to be revised to include filtration.

** 30% General Contingency

*** 30% allowance for engineering, legal, construction, financial and administration costs

6. CONCLUSIONS

The study has identified the following conclusions:

1. The existing permanent population of Bamfield is approximately 155, with a peak summer population of approximately 2,000.
2. The population in Bamfield is expected to increase to 235 permanent residents and a peak summer population of approximately 3,246 by 2053.
3. Total existing reservoir storage capacity is 545 m^3, which is sufficient for the projected future 2053 demands.
4. The current estimated maximum day demand of the system is 4.65 lps, which is projected to increase to 7.86 lps by 2053.
5. The current estimated peak hour demand of the system is 7.86 lps, which is projected to increase to 12.62 lps by 2053.
6. The age of the water, from the intake through the reservoirs and into the distribution system ranges from 30 hours to 475 hours with the existing system configuration.
7. The existing pumps are not operating at their peak efficiency, as they have to be throttled to prevent negative pressures in the supply main.
8. The peak hour pressures in the system are above 40 psi, with the exception of the areas on Binnacle Road east of Seabird Way, which are above an elevation of 50 m. If development were to occur in this area, a pump station would be required to provide the minimum peak hour pressures.
9. The following areas do not meet the minimum standard residential fire flows:
    a. West side of Bamfield
    b. Seabird Way
    c. Whistlebouy
    d. Tower Road east of Rocky Lane
    e. Bamfield Road south of Imperial Eagle Drive

7. RECOMMENDATIONS

Based on the conclusions listed in this report, it is recommended that the ACRD:

1. Continue to recorded monthly flow data and implement a strategy to record the daily flows during the peak summer months to confirm maximum day flows with the projected values listed in the report.
2. Confirm the chlorine decay rate in the system and correlate the data to the age analysis performed in the report to provide an estimate of the residual chlorine in the system.
3. Provide domestic demands only to the distribution system. Fire protection would be limited to the available fire flows with the current system configuration.
4. Monitor and perform regularly scheduled maintenance on the existing reservoirs, including cleaning and painting.
5. Prepare and implement an operation and maintenance plan for the water system including a water sampling program.
6. Prepare and implement an infrastructure renewal program for the existing distribution network.
7. Monitor the existing supply main for leakage and salt-water intrusion.
8. Complete a pilot-testing study in order to determine the optimal water treatment for the raw water from Sugsaw Lake, after confirming with VIHA that a filtration deferral can be approved for this application.
9. Obtain VIHA approval for the selected water treatment process.
10. Construct the new water treatment facility near the existing pump station to reduce the amount of infrastructure required to connect to the distribution system.
11. Monitor the turbidity levels in Sugsaw Lake to confirm that the turbidity levels are within VIHA requirements.
12. Consult with the local First Nations regarding a shared water treatment facility
13. Complete the following improvements (ranked in order of priority).

Improvement	Description
1.0	Upgrade Watermain to Coast Guard (65 m of 50 mm dia. PVC)
2.0	Upgrade Watermain on Tower Road (25 m of 50 mm dia. PVC)
3.0	Upgrade Existing Pump Station
4.0	Prepare a Water System Operation and Maintenance Plan
5.0	Implement New Water Treatment Plant in Phased Approach

APPENDIX A

Water Quality Reports

North Island Laboratories
• 2755 B Moray Avenue, Courtenay, B.C. V9N 8M9 Tel: (250) 338-7786 Fax: (250) 338-7553

Certificate of Analysis

Report To: Regional District of Alberni & Clayoquot
John Thomas
3008 5th Ave.
Port Alberni, BC V9Y 2E3
V9Y 2E3

Lab Number: 99388
Date Reported: 30 Nov 12
Date Completed: 30 Nov 12
Date Received: 22 Nov 12 11:35

Sampled By:
Sampling Date: 21 Nov 12 0:00

Test	Result	Units	Detection Limit
99388-01 Sugsaw Lake raw	**Bamfield WS**		
Alkalinity	<20	mg/L (CaCO3)	20 mg/L (CaCO3)
Total Ammonia (N)	<0.05	mg/L	0.05 mg/L
Chloride	3.7	mg/L	0.1 mg/L
Fluoride	<0.05	mg/L	0.05 mg/L
Nitrate (N)	0.06	mg/L	0.05 mg/L
Nitrite (N)	<0.05	mg/L	0.05 mg/L
Sulphate	1.6	mg/L	0.5 mg/L
Colour - Apparent	48	Colour Units	1 Colour Units
pH	6.6	pH Units	pH Units
Conductivity	29	uS/cm	1 uS/cm
Iron Bacteria	None Detected	cfu/mL	cfu/mL
Sulphur Bacteria	None Detected	cfu/mL	cfu/mL
T-Mercury	<0.0001	mg/L	0.0001 mg/L
Sulphide	<0.005	mg/L	0.005 mg/L
Total Coliforms (MF)	270	CFU/100mL	1 CFU/100mL
E. coli (MF)	3	CFU/100mL	1 CFU/100mL
Non-Coliform Background	290	CFU/100mL	1 CFU/100mL
Total Dissolved Solids	32	mg/L dried at 180 °C	7 mg/L dried at 180
Total Organic Carbon	5.7	mg/L	0.5 mg/L
Total Organic Nitrogen	0.18	mg/L	0.08 mg/L
Total Plate Count	30	CFU/ml	3 CFU/ml
T-Aluminium	0.166	mg/L	0.005 mg/L
T-Antimony	<0.0001	mg/L	0.0001 mg/L
T-Arsenic	<0.00005	mg/L	0.00005 mg/L
T-Barium	0.00514	mg/L	0.00005 mg/L
T-Beryllium	<0.00005	mg/L	0.00005 mg/L
T-Boron	0.02	mg/L	0.002 mg/L

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99388-01	**Sugsaw Lake raw**	**Bamfield WS**		
T-Bismuth		<0.0001	mg/L	0.0001 mg/L
T-Cadmium		<0.00001	mg/L	0.00001 mg/L
T-Calcium		2.26	mg/L	0.05 mg/L
T-Chromium		<0.0005	mg/L	0.0005 mg/L
T-Cobalt		<0.0001	mg/L	0.0001 mg/L
T-Copper		0.0005	mg/L	0.0001 mg/L
T-Iron		0.097	mg/L	0.002 mg/L
T-Lead		<0.0001	mg/L	0.0001 mg/L
T-Lithium		<0.0005	mg/L	0.0005 mg/L
T-Magnesium		0.5	mg/L	0.04 mg/L
T-Manganese		0.0091	mg/L	0.001 mg/L
T-Molybdenum		0.00008	mg/L	0.00005 mg/L
T-Nickel		<0.0002	mg/L	0.0002 mg/L
T-Potassium		0.1	mg/L	0.1 mg/L
T-Selenium		<0.0001	mg/L	0.0001 mg/L
T-Silicon		1.5	mg/L	0.02 mg/L
T-Silver		0.00004	mg/L	0.0005 mg/L
T-Sodium		2.7	mg/L	0.1 mg/L
T-Strontium		0.0113	mg/L	0.0001 mg/L
T-Thallium		<0.00001	mg/L	0.00001 mg/L
T-Tin		<0.0001	mg/L	0.0001 mg/L
T-Titanium		0.0016	mg/L	0.0005 mg/L
T-Uranium		<0.00001	mg/L	0.00001 mg/L
T-Vanadium		0.0003	mg/L	0.0001 mg/L
T-Zinc		0.0017	mg/L	0.0005 mg/L
Hardness (CaCO3)		2.1	mg/L	1 mg/L
Turbidity		0.6	NTU's	0.5 NTU's

North Island Laboratories
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99388-01

Spoke to Janice. There is a chlorination system in place. Cb Nov 23rd

Test	Method	Analyst	Date
Alkalinity	Titration to 4.5, APHA 2320 B -modified	NIsL	11/22/2012
Chloride	Ion Chromatography, EPA 300.1 -modified	NIsL	11/22/2012
Colour - Apparent	Spectrophotometer, APHA 2120 C -modified	NIsL	11/22/2012
Conductivity	Conductivity @25C, APHA 2510 B -modified	NIsL	11/22/2012
E. coli (MF)	Partition method, APHA 9222 G -modified	NIsL	11/22/2012
Fluoride	Ion Chromatography, EPA 300.1 -modified	NIsL	11/22/2012
Hardness (CaCO3)	Hardness by Calculation, APHA 2340 B -modified	EXL	11/26/2012
Iron Bacteria	Subcontracted Test	MBL	11/22/2012
Nitrate (N)	Ion Chromatography, EPA 300.1 -modified	NIsL	11/22/2012
Nitrite (N)	Ion Chromatography, EPA 300.1 -modified	NIsL	11/22/2012
Non-Coliform Background	Membrane Filtration, APHA 9222-B -modified	NIsL	11/22/2012
pH	Electrometric, APHA 4500 B -modified	NIsL	11/22/2012
Sulphate	Ion Chromatography, EPA 300.1 -modified	NIsL	11/22/2012
Sulphide	Exova Subcontract, Gas Dialysis APHA 4500-S2-E	EXL	11/26/2012
Sulphur Bacteria	Subcontracted Test	MBL	11/22/2012
T-Aluminium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Antimony	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Arsenic	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Barium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Beryllium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Bismuth	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Boron	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Cadmium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Calcium	Exova Subcontract, ICP, APHA 3120B -modified	EXL	11/26/2012
T-Chromium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Cobalt	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Copper	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Iron	Exova Subcontract, ICP, APHA 3120B -modified	EXL	11/26/2012
T-Lead	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Lithium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Magnesium	Exova Subcontract, ICP, APHA 3120B-modified	EXL	11/26/2012
T-Manganese	Exova Subcontract, ICP, APHA 3120B -modified	EXL	11/26/2012
T-Mercury	Exova Subcontract, Atomic Absorb, MDMES 245.1	EXL	11/28/2012
T-Molybdenum	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012

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T-Nickel	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Potassium	Exova Subcontract, ICP, APHA 3120B - modified	EXL	11/26/2012
T-Selenium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Silicon	Exova Subcontract, ICP, APHA 3120B - modified	EXL	11/26/2012
T-Silver	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Sodium	Exova Subcontract, ICP, APHA 3120B - modified	EXL	11/26/2012
T-Strontium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Thallium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Tin	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Titanium	Exova Subcontract, ICP, APHA 3120B - modified	EXL	11/26/2012
T-Uranium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Vanadium	Exova Subcontract, ICP, APHA 3120B - modified	EXL	11/26/2012
T-Zinc	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
Total Ammonia (N)	Exova Subcontract, APHA 4500-NH3 C -modified	EXL	11/27/2012
Total Coliforms (MF)	Membrane Filtration, APHA 9222 B -modified	NIsL	11/22/2012
Total Dissolved Solids	Exova Subcontract, dried @180C,APHA 2540C-modified	EXL	11/28/2012
Total Organic Carbon	Exova Subcontract, Ch.34 SSSA BookSeries5-modified	EXL	11/26/2012
Total Organic Nitrogen	Exova Subcontract, Ch.37 SSSA BookSeries5-modified	EXL	11/26/2012
Total Plate Count	Membrane Filtration, APHA 9215 D -modified	NIsL	11/22/2012
Turbidity	Nephelometric, APHA 2130 B -modified	NIsL	11/22/2012

Approved By: 

Catherine Black, Owner/Operator

North Island Laboratories
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Certificate of Analysis

Report To: Regional District of Alberni & Clayoquot
John Thomas
3008 5th Ave.
Port Alberni, BC V9Y 2E3
V9Y 2E3

Lab Number: 91955
Date Reported: 8 Dec 11
Date Completed: 8 Dec 11
Date Received: 29 Nov 11 9:42

91955-01 Sugsaw Lake - Bamfield

Sampled By: John Thomas
Sampling Date: 28 Nov 11 0:00

Test	Result	Units	Drinking Water Guideline
Total Coliforms (DES)	83.1	MPN/100mL	<1
E. coli (DES)	1.0	MPN/100mL	<1
pH	6.7	pH Units	6.5-8.5
Alkalinity	<20	mg/L (CaCO3)	
Turbidity	<0.5	NTU's	5 AO
Total Dissolved Solids (conductivity ca	20	mg/L	500 AO
Fluoride	<0.05	mg/L	1.5 MAC
Chloride	3.5	mg/L	250 AO
Nitrate (N)	0.05	mg/L	10 MAC
Nitrite (N)	<0.05	mg/L	1 MAC
Sulphate	1.5	mg/L	500 AO
T-Aluminium	0.153	mg/L	0.1 Operational Std.
T-Antimony	<0.0002	mg/L	0.006 MAC
T-Arsenic	<0.0002	mg/L	0.010 MAC
T-Barium	0.004	mg/L	1.0 MAC
T-Beryllium	<0.00004	mg/L	
T-Bismuth	<0.001	mg/L	
T-Boron	0.02	mg/L	5 IMAC
T-Cadmium	<0.00001	mg/L	0.005 MAC
T-Calcium	2.22	mg/L	
T-Chromium	<0.0004	mg/L	0.05 MAC
T-Cobalt	<0.00002	mg/L	
T-Copper	<0.001	mg/L	1.0 AO
T-Iron	0.094	mg/L	0.3 AO
T-Lead	<0.0001	mg/L	0.010 MAC
T-Lithium	<0.001	mg/L	

AO = Aesthetic Objective; MAC = Max. Allowable Concentration; IMAC = Interim MAC
> = Greater than; < = Less than

Canadian Drinking Water Guidelines as listed on Dec. 5th, 2005 and are subject to

North Island Laboratories
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91955-01 Sugsaw Lake - Bamfield

Sampled By: John Thomas

Sampling Date: 28 Nov 11 0:00

Test	Result	Units	Drinking Water Guideline
T-Magnesium	0.49	mg/L	
T-Manganese	0.013	mg/L	0.05 AO
T-Molybdenum	<0.0001	mg/L	
T-Nickel	<0.001	mg/L	
T-Phosphorus	<0.01	mg/L	
T-Potassium	0.2	mg/L	
T-Selenium	<0.0006	mg/L	0.01 MAC
T-Silicon	1.36	mg/L	
T-Silver	<0.00001	mg/L	
T-Sodium	2.62	mg/L	200 AO
T-Strontium	0.012	mg/L	
T-Thallium	<0.00001	mg/L	
T-Tin	<0.0001	mg/L	
T-Titanium	0.002	mg/L	
T-Uranium	<0.0004	mg/L	0.02 MAC
T-Vanadium	0.0002	mg/L	
T-Zinc	0.001	mg/L	5 AO
Hardness (CaCO3)	7.6	mg/L	
Colour - Apparent	54	Colour units	15 AO
Tannins & Lignins	1	mg/L	0.4 AO
UV Transmittance	60.5	%/cm	

AO = Aesthetic Objective; MAC = Max. Allowable Concentration; IMAC = Interim MAC
> = Greater than; < = Less than

Canadian Drinking Water Guidelines as listed on Dec. 5th, 2005 and are subject to

North Island Laboratories
• 2755 B Moray Avenue, Courtenay, B.C. V9N 8M9 Tel: (250) 338-7786 Fax: (250) 338-7553

91955-01

This water sample, at the time it was taken, does not meet the Canadian Drinking Water Guidelines for one or more of the parameters tested. Please refer to your results.
This analysis is not to be interpreted as a Water Potability Certificate as this is beyond the authority of North Island Laboratories Ltd.
We suggest the following Health Canada website for further information regarding the latest drinking water quality guidelines to help you assess your results:
http://www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/guide/index-eng.php

Test	Method	Analyst	Date
Alkalinity	Titration to 4.5, APHA 2320 B -modified	NIsL	01/12/2011
Chloride	Ion Chromatography, EPA 300.1 -modified	NIsL	01/12/2011
Colour - Apparent	Exova Subcontract, APHA 2120 C -modified	EXL	12/01/2011
E. coli (DES)	Enzyme Substrate, APHA 9223 B -modified		29/11/2011
Fluoride	Ion Chromatography, EPA 300.1 -modified	NIsL	01/12/2011
Hardness (CaCO3)	Hardness by Calculation, APHA 2340 B -modified	NIsL	07/12/2011
Nitrate (N)	Ion Chromatography, EPA 300.1 -modified	NIsL	25/11/2011
Nitrite (N)	Ion Chromatography, EPA 300.1 -modified	NIsL	01/12/2011
pH	Electrometric, APHA 4500 B -modified	NIsL	29/11/2011
Sulphate	Ion Chromatography, EPA 300.1 -modified	NIsL	01/12/2011
T-Aluminium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Antimony	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Arsenic	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Barium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Beryllium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Bismuth	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Boron	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Cadmium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Calcium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Chromium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Cobalt	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Copper	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Iron	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Lead	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Lithium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Magnesium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Manganese	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Molybdenum	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Nickel	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Phosphorus	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011

AO = Aesthetic Objective; MAC = Max. Allowable Concentration; IMAC = Interim MAC
> = Greater than; < = Less than

Canadian Drinking Water Guidelines as listed on Dec. 5th, 2005 and are subject to

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T-Potassium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Selenium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Silicon	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Silver	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Sodium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Strontium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Thallium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Tin	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Titanium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Uranium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Vanadium	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
T-Zinc	Exova Subcontract, ICP-AES,EPA6010C,200.8-modified	EXL	30/11/2011
Tannins & Lignins	Exova Subcontract,Colorimetric,APHA 5550B-modified	EXL	12/01/2011
Total Coliforms (DES)	Enzyme Substrate, APHA 9223 B -modified	NIsL	29/11/2011
Total Dissolved Solids (conducti	Conductivity @25C, APHA 2510 A -modified	NIsL	01/12/2011
Turbidity	Nephelometric, APHA 2130 B -modified	NIsL	29/11/2011
UV Transmittance	Exova Subcontract, APHA 5910 B -modified	EXL	30/11/2011

Approved By: Catherine Black

Catherine Black, Owner/Operator

AO = Aesthetic Objective; MAC = Max. Allowable Concentration; IMAC = Interim MAC
> = Greater than; < = Less than
Results relate only to samples as submitted. This certificate must not be reproduced, except in its entirety, without written consent from the laboratory.
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Certificate of Analysis

Report To: Regional District of Alberni & Clayoquot
John Thomas
3008 5th Ave.
Port Alberni, BC V9Y 2E3
V9Y 2E3

Lab Number: 99390
Date Reported: 30 Nov 12
Date Completed: 30 Nov 12
Date Received: 22 Nov 12 11:52

Sampled By:
Sampling Date: 21 Nov 12 0:00

Test	Result	Units	Detection Limit
99390-01 Bamfield Marine Station Butler residence			
Bromodichloromethane	0.005	mg/L	0.001 mg/L
Bromoform	<0.001	mg/L	0.001 mg/L
Chloroform	0.254	mg/L	0.001 mg/L
Dibromochloromethane	<0.001	mg/L	0.001 mg/L
Total Trihalomethanes	0.259	mg/L	0.001 mg/L

99390-01

Test	Method	Analyst	Date
Bromodichloromethane	Exova Subcontract-EPA 8260B/5035 - modified	EXL	11/26/2012
Bromoform	Exova Subcontract-EPA 8260B/5035 - modified	EXL	11/26/2012
Chloroform	Exova Subcontract-EPA 8260B/5035 - modified	EXL	11/26/2012
Dibromochloromethane	Exova Subcontract-EPA 8260B/5035 - modified	EXL	11/26/2012
Total Trihalomethanes	Exova Subcontract-EPA 8260B/5035 - modified	EXL	11/26/2012

Approved By: Catherine Black

Catherine Black, Owner/Operator

North Island Laboratories
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Certificate of Analysis

Report To: Regional District of Alberni & Clayoquot
John Thomas
3008 5th Ave.
Port Alberni, BC V9Y 2E3
V9Y 2E3

Lab Number: 99389
Date Reported: 30 Nov 12
Date Completed: 30 Nov 12
Date Received: 22 Nov 12 11:47

Sampled By:
Sampling Date: 21 Nov 12 0:00

Test	Result	Units	Detection Limit
99389-01 BWS Reservoir	**Bamfield WS**		
Alkalinity	<20	mg/L (CaCO3)	20 mg/L (CaCO3)
Total Ammonia (N)	<0.05	mg/L	0.05 mg/L
Chloride	11.1	mg/L	0.1 mg/L
Fluoride	<0.05	mg/L	0.05 mg/L
Nitrate (N)	<0.05	mg/L	0.05 mg/L
Nitrite (N)	<0.05	mg/L	0.05 mg/L
Sulphate	1.7	mg/L	0.5 mg/L
Colour - Apparent	14	Colour Units	1 Colour Units
pH	6.7	pH Units	pH Units
Conductivity	61	uS/cm	1 uS/cm
Iron Bacteria	None Detected	cfu/mL	cfu/mL
Sulphur Bacteria	None Detected	cfu/mL	cfu/mL
T-Mercury	<0.0001	mg/L	0.0001 mg/L
Sulphide	<0.005	mg/L	0.005 mg/L
Total Coliforms (MF)	<1	CFU/100mL	1 CFU/100mL
E. coli (MF)	<1	CFU/100mL	1 CFU/100mL
Non-Coliform Background	<1	CFU/100mL	1 CFU/100mL
Total Dissolved Solids	42	mg/L dried at 180 °C	7 mg/L dried at 180
Total Organic Carbon	5	mg/L	0.5 mg/L
Total Organic Nitrogen	0.12	mg/L	0.08 mg/L
Total Plate Count	<3	CFU/ml	3 CFU/ml
T-Aluminium	0.147	mg/L	0.005 mg/L
T-Antimony	<0.0001	mg/L	0.0001 mg/L
T-Arsenic	<0.00005	mg/L	0.00005 mg/L
T-Barium	0.00624	mg/L	0.00005 mg/L
T-Beryllium	<0.00005	mg/L	0.00005 mg/L
T-Boron	0.022	mg/L	0.002 mg/L

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99389-01	**BWS Reservoir**	**Bamfield WS**		
T-Bismuth		<0.0001	mg/L	0.0001 mg/L
T-Cadmium		<0.00001	mg/L	0.00001 mg/L
T-Calcium		2.89	mg/L	0.05 mg/L
T-Chromium		<0.0005	mg/L	0.0005 mg/L
T-Cobalt		<0.0001	mg/L	0.0001 mg/L
T-Copper		0.003	mg/L	0.0001 mg/L
T-Iron		0.099	mg/L	0.002 mg/L
T-Lead		0.0004	mg/L	0.0001 mg/L
T-Lithium		<0.0005	mg/L	0.0005 mg/L
T-Magnesium		0.52	mg/L	0.04 mg/L
T-Manganese		0.004	mg/L	0.001 mg/L
T-Molybdenum		0.00009	mg/L	0.00005 mg/L
T-Nickel		<0.0002	mg/L	0.0002 mg/L
T-Potassium		0.1	mg/L	0.1 mg/L
T-Selenium		<0.0001	mg/L	0.0001 mg/L
T-Silicon		1.56	mg/L	0.02 mg/L
T-Silver		0.00003	mg/L	0.0005 mg/L
T-Sodium		8.8	mg/L	0.1 mg/L
T-Strontium		0.014	mg/L	0.0001 mg/L
T-Thallium		<0.00001	mg/L	0.00001 mg/L
T-Tin		<0.0001	mg/L	0.0001 mg/L
T-Titanium		0.0008	mg/L	0.0005 mg/L
T-Uranium		<0.00001	mg/L	0.00001 mg/L
T-Vanadium		0.0002	mg/L	0.0001 mg/L
T-Zinc		0.0168	mg/L	0.0005 mg/L
Hardness (CaCO3)		9.4	mg/L	1 mg/L
Bromodichloromethane		0.005	mg/L	0.001 mg/L
Bromoform		<0.001	mg/L	0.001 mg/L
Chloroform		0.252	mg/L	0.001 mg/L
Dibromochloromethane		<0.001	mg/L	0.001 mg/L
Total Trihalomethanes		0.257	mg/L	0.001 mg/L
Turbidity		0.6	NTU's	0.5 NTU's

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99389-01

Test	Method	Analyst	Date
Alkalinity	Titration to 4.5, APHA 2320 B -modified	NIsL	11/22/2012
Bromodichloromethane	Exova Subcontract-EPA 8260B/5035 - modified	EXL	11/26/2012
Bromoform	Exova Subcontract-EPA 8260B/5035 - modified	EXL	11/26/2012
Chloride	Ion Chromatography, EPA 300.1 -modified	NIsL	11/22/2012
Chloroform	Exova Subcontract-EPA 8260B/5035 - modified	EXL	11/26/2012
Colour - Apparent	Spectrophotometer, APHA 2120 C -modified	NIsL	11/22/2012
Conductivity	Conductivity @25C, APHA 2510 B -modified	NIsL	11/22/2012
Dibromochloromethane	Exova Subcontract-EPA 8260B/5035 - modified	EXL	11/26/2012
E. coli (MF)	Partition method, APHA 9222 G -modified	NIsL	11/22/2012
Fluoride	Ion Chromatography, EPA 300.1 -modified	NIsL	11/22/2012
Hardness (CaCO3)	Hardness by Calculation, APHA 2340 B -modified	EXL	11/26/2012
Iron Bacteria	Subcontracted Test	MBL	11/22/2012
Nitrate (N)	Ion Chromatography, EPA 300.1 -modified	NIsL	11/22/2012
Nitrite (N)	Ion Chromatography, EPA 300.1 -modified	NIsL	11/22/2012
Non-Coliform Background	Membrane Filtration, APHA 9222-B -modified	NIsL	11/22/2012
pH	Electrometric, APHA 4500 B -modified	NIsL	11/22/2012
Sulphate	Ion Chromatography, EPA 300.1 -modified	NIsL	11/22/2012
Sulphide	Exova Subcontract, Gas Dialysis APHA 4500-S2-E	EXL	11/26/2012
Sulphur Bacteria	Subcontracted Test	MBL	11/22/2012
T-Aluminium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Antimony	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Arsenic	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Barium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Beryllium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Bismuth	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Boron	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Cadmium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Calcium	Exova Subcontract, ICP, APHA 3120B -modified	EXL	11/26/2012
T-Chromium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Cobalt	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Copper	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Iron	Exova Subcontract, ICP, APHA 3120B -modified	EXL	11/26/2012
T-Lead	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Lithium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012

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T-Magnesium	Exova Subcontract, ICP, APHA 3120B-modified	EXL	11/26/2012
T-Manganese	Exova Subcontract, ICP, APHA 3120B -modified	EXL	11/26/2012
T-Mercury	Exova Subcontract, Atomic Absorb, MDMES 245.1	EXL	11/28/2012
T-Molybdenum	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Nickel	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Potassium	Exova Subcontract, ICP, APHA 3120B - modified	EXL	11/26/2012
T-Selenium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Silicon	Exova Subcontract, ICP, APHA 3120B - modified	EXL	11/26/2012
T-Silver	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Sodium	Exova Subcontract, ICP, APHA 3120B - modified	EXL	11/26/2012
T-Strontium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Thallium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Tin	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Titanium	Exova Subcontract, ICP, APHA 3120B - modified	EXL	11/26/2012
T-Uranium	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
T-Vanadium	Exova Subcontract, ICP, APHA 3120B - modified	EXL	11/26/2012
T-Zinc	Exova Subcontract, ICP-MS,USEPA 200.8-modified	EXL	11/26/2012
Total Ammonia (N)	Exova Subcontract, APHA 4500-NH3 C -modified	EXL	11/27/2012
Total Coliforms (MF)	Membrane Filtration, APHA 9222 B -modified	NIsL	11/22/2012
Total Dissolved Solids	Exova Subcontract, dried @180C,APHA 2540C-modified	EXL	11/28/2012
Total Organic Carbon	Exova Subcontract, Ch.34 SSSA BookSeries5-modified	EXL	11/26/2012
Total Organic Nitrogen	Exova Subcontract, Ch.37 SSSA BookSeries5-modified	EXL	11/26/2012
Total Plate Count	Membrane Filtration, APHA 9215 D -modified	NIsL	11/22/2012
Total Trihalomethanes	Exova Subcontract-EPA 8260B/5035 - modified	EXL	11/26/2012
Turbidity	Nephelometric, APHA 2130 B -modified	NIsL	11/22/2012

Approved By: 

Catherine Black, Owner/Operator

APPENDIX B

Sugsaw Lake Water Licence

CONDITIONAL WATER LICENCE

Regional District of Alberni - Clayoquot of 4586 Victoria Quay, Port Alberni, B.C. V9Y 6G3

is hereby authorized to divert and use water as follows:

(a) The source of the water-supply is Sugsaw Lake.

(b) The point of diversion is located as shown on the attached plan.

(c) The date from which this licence shall have precedence is 19th July, 1979.

(d) The purpose for which the water is to be used is waterworks. 1136 m³/day 13.2 lps

(e) The maximum quantity of water which may be diverted is 250,000 gallons a day, and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(f) The period of the year during which the water may be used is the whole year.

(g) The land upon which the water is to be used and to which this licence is appurtenant is all the lands within the boundaries of Bamfield Community within the Regional District of Alberni Clayoquot.

(h) The works authorized to be constructed are diversion structure, pipe, pump and tank, which shall be located approximately as shown on the attached plan.

(i) The construction of the said works shall be commenced on or before the 31st day of January, 1982, and shall be completed and the water beneficially used on or before the 31st day of December, 1984.

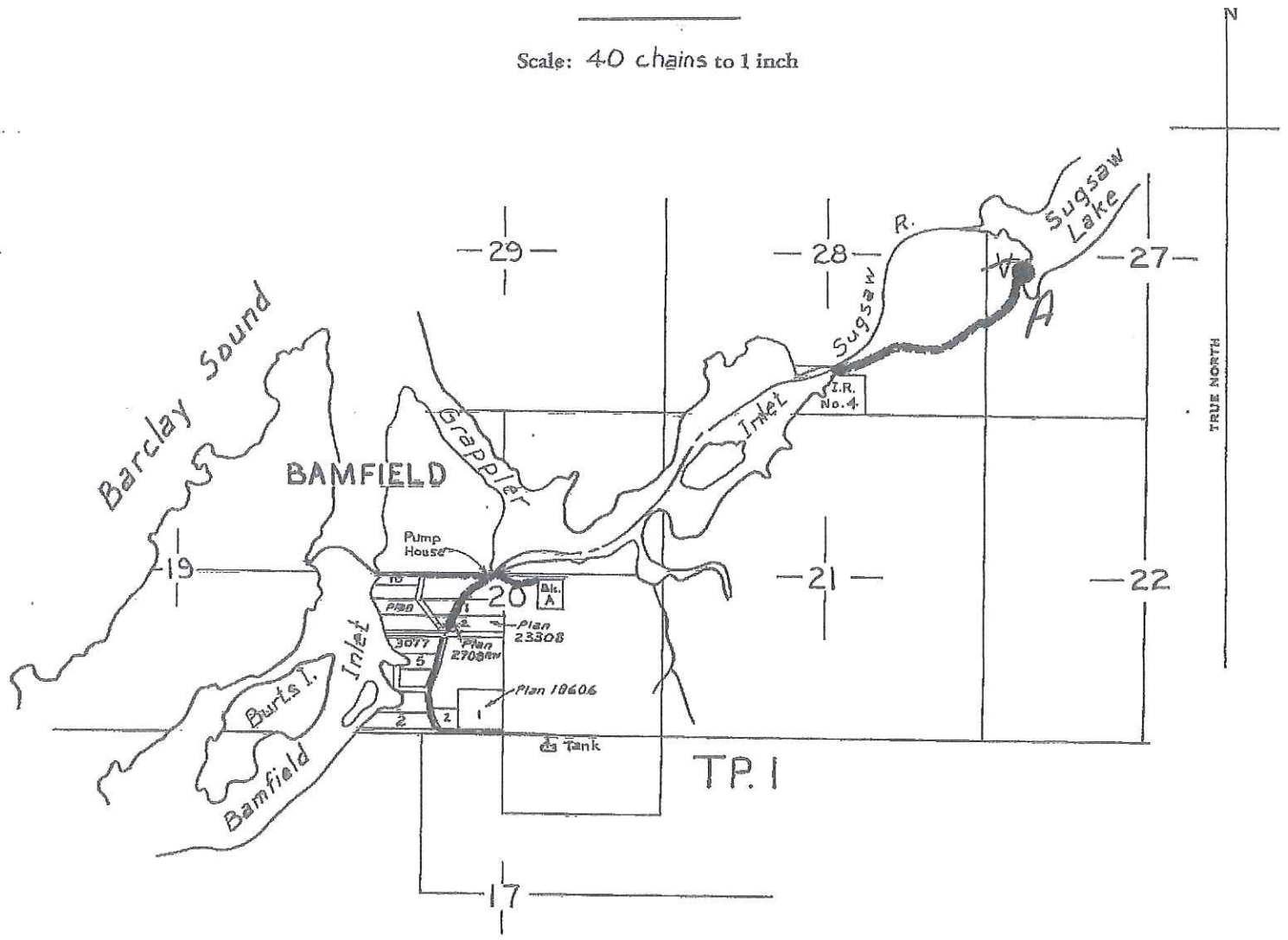
(j) The withdrawal of water from Sugsaw Lake shall be monitored regulary by means of a flow meter and regular lake level readings will also be required. Resulting data shall be made available to the Engineer for the Alberni Water District.

ENTERED ON
Map No. 2
By VO DMB

J.E. Farrell,
Deputy Comptroller of Water Rights.

ALBERNI WATER DISTRICT
BARCLAY DISTRICT

Scale: 40 chains to 1 inch



LEGEND

Point of Diversion ●
W.R. Map ~~2~~ 92.C.085.2.3
Pipe — — —
Right of Way ▬▬▬

The boundaries of the land to which this licence is appurtenant are Alberni - Clayoquot Regional District

Signature [signature]

Date 15th July 1981

CL 55723
File 0365962
R/W Permit 12867

Alberni Precinct

Water Licences Report

Scroll to bottom of page for unique count of licences and/or applications found in your search

Licence No	WR Map/ Point Code	Stream Name	Purpose	Quantity	Units	Qty Flag	Rediv Flag	Licensee	Water District/Precinct	Licence Status	Process Status	Priority Date	Issue Date
C055723	92.C.085.2.3 A (PD29503)	Sugsaw Lake	Waterworks Local Auth	414830.713	MY	T	N	REGIONAL DISTRICT OF ALBERNI-CLAYOQUOT 3008 5 AVE PORT ALBERNI BC V9Y2E3	ALB - ALBERNI	Current	N/A	19790719	

Total number of Licences and/or Applications found is **1**

New Query

Use the BACK button on the browser to retain previous search criteria

APPENDIX C

Existing Pump Information

RICH-TEK INDUSTRIES

#104-2802 Mt. Lehman Rd.
Abbotsford BC V4X 2N3

Phone: 604-278-9888
Fax 1-866-220-5393

Domestic Water Booster Startup report

Date: WED June 4TH & 23RD **Customer:** WESTERN TECHNICAL

Job#: 11033 & 11125 **Address:** BAMfield (Grappler Rd)

By: KD

EQUIPMENT DATA

Simplex ☐ Duplex ☑ Triplex ☐ **Make:** PLAD

Pump# 1
Make: GRUNDFOS
Model: CR45
Serial: A964158188
GPM 237.7 @ 247.4 ft.

Pump# 2
Make: GRUNDFOS
Model: CR45
Serial: A964158219
GPM 237.7 @ 247.4 ft.

Pump# 3
Make: _____
Model: _____
Serial: _____
GPM _____ @ _____ psi/ft.

Motor# 1
Make: Baldor H.P. 20
RPM: 3540 Volts: 208
Fr: TEFC Encl: 256TC S.F. 1.15

Motor# 2
Make: Baldor H.P. 20
RPM: 3540 Volts: 208
Fr: 256TC Encl: TEFC S.F. 1.15

Motor# 3
Make: _____ H.P. _____
RPM: _____ Volts: _____
Fr: _____ Encl: _____ S.F. _____

PRV# 1
Make: _____
Model: _____
Size: _____ Range: _____

PRV# 2
Make: _____
Model: _____
Size: _____ Range: _____

PRV# 3
Make: _____
Model: _____
Size: _____ Range: _____

Controller: Make: PLAD Model: OBF S/N: 1039-002

SETUP DATA

Pump – 1	On @ N/A	Off @ N/A	Continuous _____	Amps: L1 38	L2 38 L3 39
Pump – 2	On @ _____	Off @ _____	_____	Amps: L1 38	L2 38 L3 38
Pump – 3	On @ _____	Off @ _____	_____	Amps: L1 _____	L2 _____ L3 _____
Min. run timer settings:				P-1 _____	P-2 _____ P-3 _____
Current relay settings:	3sec's & 45v			P-1 _____	P-2 _____ P-3 _____
Aquastat settings:	45° C			P-1 _____	P-2 _____ P-3 _____
PRV settings:				P-1 _____	P-2 _____ P-3 _____
Low suction pressure shutdown:	0 Psi			Off @ N/A psi,	On @ N/A psi
High suction pressure shutdown:	150 Psi			Off @ _____ psi,	On @ _____ psi
Delay timer, low suction shutdown:	15 SEC			Set @ _____	seconds
Delay timer, high suction shutdown:	15 sec			Set @ _____	seconds

7 day timer: Weekdays, On @ _____ Off @ _____, Weekends, On @ _____ Off @ _____

Other settings or comments:

Pumps are operated by floats and voltage RELAY's.
Both pumps are set to Run @ 53 Hz @ 102 psi and 140 GPM @ 3180 RPM
Low suction is set with a auto restart
Low system pressure set @ 20 psi with an auto RESTART
SET to Alternate every 48 hrs